Designing a Strategic Bomber:

Evolving Operational Concepts

A Monograph
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This monograph examined the employment of strategic bombers during three campaigns: B-29 operations in the Pacific Theater, B-52 operations during Desert Storm, and strategic bomber operations during Operation Enduring Freedom. This examination revealed that the Air Force modified the technology and tactics employed by strategic bomber crews during the course of each campaign. The operational concept for strategic bombers has evolved over time. Air Force leaders must strive for complete knowledge of the enemy and operational environment, but assume that they will never achieve complete understanding. To overcome this limitation, the Air Force must design flexibility into the organizations, tactics, and technology they use to execute strategic bomber operations.

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ABSTRACT

DESIGNING A STRATEGIC BOMBER: EVOLVING OPERATIONAL CONCEPTS by Major David J. Gordon, USAF, 47 pages.

Developing a strategic bomber in today's budget constrained environment is a challenging prospect. The design requirements must address conflict across the spectrum and remain relevant regardless of the enemy America faces. The operational concept for strategic bombers must address a multitude of considerations despite the complexity of a changing environment. The key to enduring relevancy is operational adaptability through flexible organizations, tactics, and technology.

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I would like to thank my wife Kimberly and daughters Kaitlyn and Lauren for their unwavering support, encouragement, and love.

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ACRONYMS

AAF	Army Air Force
ACTS	Air Corps Tactical School
AFM	Air Force Manual
ALCM	Air-Launched Cruise Missile
AWPD	Air War Plans Division
CALCM	Conventional Air-Launched Cruise Missile
CENTCOM	United States Central Command
COA	Committee of Operations Analysts
DoD	Department of Defense
ECM	Electronic Counter Measures
FM	Field Manual
GBU	Guided Bomb Unit
GPS	Global Positioning System
HAPDB	High-Altitude, Precision, Daylight Bombing
JDAM	Joint Direct Attack Munition
JSOW	Joint Standoff Weapon
OPLAN	Operations Plan
SAC	Strategic Air Command
TAC	Tactical Air Command
USSBS	United States Strategic Bombing Survey
WCMD	Wind Corrected Munitions Dispenser

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Introduction

On 6 April 2009, Defense Secretary Gates deferred the development program for a follow-on Air Force bomber until "we have a better understanding of the need, the requirement, and the technology."[1] This decision raised many questions about the future of the strategic bomber: what direction did the Air Force want to go with the strategic bomber fleet, what requirements had been identified, and what is the focus of a new bomber development program? Secretary Gates and Air Force leaders later testified that the Department of Defense (DoD) needed a new bomber platform, but the Air Force's lack of defined requirements for a new bomber warranted delaying the costly development program.[2] Today's uncertain international security environment suggests that a strategic bomber is a necessary capability for full-spectrum operations.

The Air Force did not base its new bomber program on the retirement of existing bomber aircraft, but rather the pending retirement of the Air-Launched Cruise Missile (ALCM) carried by the B-52H.[3] The ALCM retirement creates a capability gap for bomber nuclear delivery and generates questions about future viability of the bomber nuclear forces. Air Force officials appeared set on fielding the 2018 bomber as a stopgap measure to ensure continuity in bomber nuclear delivery capability. The progression of thought about nuclear deterrence caused DoD leadership to reconsider the appropriateness of developing a new nuclear bomber. Yet, the nuclear mission is only one aspect of a range of capabilities that DoD officials must consider.

The role and mission of the bomber fleet has changed since the end of the Cold War. The bomber fleet continues to perform a role in nuclear deterrence, but the primacy of this role has diminished. The

[1] Secretary Robert M. Gates, "Defense Secretary Robert Gates Releases Budget," *transcript,* online at http://www.washingtonpost.com/wp-srv/politics/documents/gates_defense_budget_040609.html (accessed November 17, 2009).

[2] Jim Wolf, "Gates Endorses New Bomber Program" *Reuters*, September 16, 2009, online at http://www.reuters.com/article/idUSTRE58F53R20090916 (accessed February 17, 2010).

[3] Ronald O'Rourke, *Air Force Next-Generation Bomber: Background Issues for Congress* (Washington DC: Congressional Research Service, August 3, 2009), 7.

Department of Defense stood down nuclear alert bomber forces in 1991 and Air Force emphasis on the nuclear mission has slowly eroded.[4] Meanwhile, the bomber's role in conventional operations has expanded dramatically. Conventional operations in Operations Desert Storm, Desert Strike, Desert Fox, Allied Force, Enduring Freedom, and Iraqi Freedom underscore the need for a capable conventional bomber fleet. The battlefield persistence and conventional payload capacity of the strategic bomber has made it a vital partner to ground forces in Afghanistan and Iraq. Yet, the ability to hold distant enemy targets at risk has been the hallmark of the strategic bomber and may play a greater role in the future.

America has seen a slow withdrawal of international support for airbases on foreign soil. Over the past two decades, the United States has access to fewer forward staging areas from which to operate its shorter-range fighter-bomber aircraft.[5] Since the end of the Cold War, the Air Force has reduced the number of permanent overseas air bases from fifty to seventeen.[6] Citizens in historically friendly nations, such as Japan, have voiced opposition against American military presence calling into question future access.[7] The slow withdrawal of foreign basing rights reveals a need for aircraft capable of global power projection. The US military needs a strategic bomber capable of long-range strike and battlefield persistence.

The primacy of conventional operations has not diminished the need for a bomber force capable of conducting nuclear deterrence. Post-Cold War nuclear proliferation increased the complexity of designing a cogent nuclear deterrence strategy and the debate over American policy for nuclear deterrence

[4] United States General Accounting Office, *Air Force Bombers: Options to Retire or Restructure the Force Would Reduce Planned Spending*, GAO-NSIAD-96-192 (Washington DC: Government Printing Office, September 1996), 23.

[5] Chairman of the Joint Chiefs of Staff, *CCJO v3.0: Capstone Concept for Joint Operations* (Washington DC: Government Printing Office, January 15, 2009), 6.

[6] William D. O'Malley, *Evaluating Possible Airfield Deployment Options* (Santa Monica, CA: RAND, Project Air Force, 2001), 2.

[7] Anthony Kuhn, "In Okinawa, Elections Renew Debate Over US Bases," *National Public Radio*, 25 January 2010, online at http://www.npr.org/templates/story/story.php?storyId=122954708 (accessed 12 February 2010).

has no clear consensus.[8] United States Strategic Command abandoned its previous deterrence strategy of the nuclear triad and replaced it with a tailored approach to deterrence requiring broad-spectrum capabilities. America should not let its nuclear response options lapse until it has identified the capabilities necessary to support future nuclear deterrence options.[9] Until then, America needs a bomber force capable in both conventional and nuclear operations.

A strategic bomber should not rely on singular asymmetric technological development to ensure access to highly defended enemy targets. Adaptive enemies find ways to marginalize asymmetric technological advancements. During the 1980's, stealth technology offered battlefield immunity and a panacea against enemy radar detection. America's enemies cast doubt on this asymmetric advantage in 1999 when Serbian forces shot down a stealth fighter using a former-Soviet Union SA-3 designed in the 1960's.[10] The Air Force based its concept of the bomber always getting through on America's ability to leverage advanced technology to overcome enemy defenses. The difficulty maintaining technological advantage suggests that the best way to gain and maintain initiative is to adapt faster than your enemy does. Therefore, the United States must avoid overreliance on a singular technological approach when designing a future bomber platform and consider how to incorporate flexibility into their methods of employing the strategic bomber.

Ask any airman what they key to airpower is and they will quickly answer "flexibility." This often-quoted truism typically refers to the inherent ability of aircraft to rapidly shift focus between missions.[11] However, another type of flexibility employed by bomber crews is less obvious and often overlooked. Operational flexibility is required when the enemy the Air Force planned for is not the

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[8] Glenn C. Buchnan, David Matonick, Calvin Shipbaugh, and Richard Mesic, *Future Roles of US Nuclear Forces: Implications of US Strategy*, (Santa Monica, CA: RAND Project Air Force, 2003), 109.

[9] Ibid., 91.

[10] Benjamin S. Lambeth, "Kosovo and the Continuing SEAD Challenge" *Aerospace Power Journal* XVI, no. 2 (Summer 2002), 12.

[11] Frederick L. Baier, "50 Questions Any Airman Can Answer" Air University Web site, online at http://www.au.af.mil/au/awc/awcgate/afdc/50questions.pdf (accessed March 18, 2010).

enemy they are fighting. Lieutenant General William Wallace said of the Iraq war, "The enemy we are fighting is a bit different than the one we wargamed against."[12] America's track record for predicting how it will wage the next war is not terribly impressive. Therefore, the methods by which the Air Force employs its strategic bombers must also be flexible to allow for modifications based on enemy adaptations to the operational environment. This monograph asks the question: How does the Air Force's wartime employment of strategic bombers differ from its pre-war operational concept?

Dr. Milan Vego defines operational concept as "an overarching structure referring in the broadest terms to how one's military forces are to operate."[13] Operational concept is a generic term that refers to theater-wide employment of forces and is an operational blueprint of how one should apply forces to achieve operational or strategic objectives.[14] Dr. Vego states, "An operational concept should be part of a larger and broader strategic concept. It should be based on a sound evaluation of potential future adversaries."[15] Operational concepts typically form the basis from which service leaders write joint and service doctrine. Senior military leaders shape operational concepts through policy, tactics, and service publications.[16] A future operational concept envisions the employment of forces in the future and remains an untested hypothesis until reasonably validated through experimentation.[17] Testing this hypothesis in a peacetime environment is impossible, but combat is the ideal validity test for an operational concept.[18]

Throughout its history, the US Air Force maintained an operational concept for strategic bombers

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[12] Jim Dwyer, "A Gulf Commander Sees a Longer Road" *New York Times*, March 28, 2003, online at http://www.nytimes.com/2003/03/28/international/worldspecial/28GENE.html?pagewanted=1 (accessed March 17, 2010).

[13] Milan Vego "Operational Art and Doctrine" in *Rethinking the Principles of War*, ed. Anthony D. McIvor (Annapolis, MD: Naval Institute Press, 2005), 176.

[14] Ibid.

[15] Ibid.

[16] Ibid.

[17] Ibid.

[18] Ibid.

that guided policy, employment tactics, and strategic bomber design. Air Force leaders based their operational concepts on the technological and tactical capabilities of existing strategic bombers. Operational concepts bridge the gap between national or military strategy and existing strategic bomber capabilities. The Air Force informally publishes strategic bomber operational concepts through academic journals, white papers, and official policy. The Air Force also provides insight into its operational concept through force structure decisions that shape military capabilities towards the concept. Air Force future operational concepts for strategic bombers guide aircraft design and influence the ways by which they employ strategic bombers.

Future operational concepts for strategic bombers are simply a hypothesis for their employment. This hypothesis may require modification during a campaign due to enemy adaptations within the operational environment. Eliot Cohen and John Gooch argue in *Military Misfortunes: The Anatomy of Failure in War* that there are three basic kinds of failure: failure to learn, failure to anticipate, and failure to adapt.[19] The authors assert, "Where learning failures have their roots in the past, and anticipatory failures look to the future, adaptive failures suggest an inability to handle the changing present."[20] Dogmatic adherence to an operational concept can lead to fundamental surprise when an adaptive enemy discovers a way to invalidate this strategy during combat. Similarly, the lack of technological flexibility in strategic bomber design can limit its ability to incorporate new technology, thus limiting the Air Force's ability to adapt during employment. Cohen and Gooch suggest, "The ability to adapt is probably the most useful to any military organization and the most characteristic of successful ones, for with it, it is possible to overcome both learning and predictive failures."[21]

Successful adaptation requires the recognition of the need to adapt, which demands an organization capable of recognizing changes in the environment and learning during campaign execution.

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[19] Eliot A. Cohen and John Gooch, *Military Misfortunes: The Anatomy of Failure in War* (New York: The Free Press, 1990), 26.

[20] Ibid., 27.

[21] Ibid., 94.

Donald Schön refers to this concept as "reflection-in-action," which is the adaptation of function to unexpected phenomenon.[22] Reflection-in-action begins with the performance of a specific function during which surprise occurs in the form of an unexpected outcome.[23] Surprise leads to reflection and experimentation intended to test understanding of the environment and produce an optimal result.[24] Successful adaptation requires the recognition of environmental changes, understanding how past events relate to the present, and understanding that previous operational concepts must be tailored to the context of the situation. Cohen and Gooch reiterate, "Military organizations should inculcate in their members a relentless empiricism, a disdain for a priori theorizing if they are to succeed."[25]

Successful adaptation also requires the organizational capability to adapt. Theorists often overlook this concept because organizations frequently discard systems that lack adaptability in favor of newer systems better suited to the context of the situation. However, the research, development, and production costs for strategic bombers are extraordinarily expensive both politically and monetarily. Air Force leaders cannot afford to discard outdated bombers, which is perhaps why the B-52 has been in the arsenal for sixty years. The Air Force must carefully consider its requirements for strategic bomber future operational concepts and select a design that enables adaptation. The capability to adapt requires flexibility in technology and technique.

Tactics are the operational techniques and procedures used by bomber crews to execute their mission. Flexibility of tactics refers to the ability of crews to modify the procedures they use to employ weapons in combat in order to achieve new or different effects. Strategic bomber aircrews have demonstrated flexibility of tactics during campaign execution, as evidenced by the case studies in this monograph. Flexibility in technology refers to how the Air Force modified the equipment or weapons used by strategic bomber crews to perform their mission. Throughout history, the Air Force upgraded the

[22] Donald A. Schön, *Education the Reflective Practitioner* (San Francisco: Jossey-Bass, 1987), 27.

[23] Ibid., 28.

[24] Ibid.

[25] Cohen and Gooch, 236.

strategic bomber fleet to incorporate technological advances in sensors, weapons, and defensive measures. Often these modifications are in response to technological advances that improve the lethality, accuracy, or asymmetric advantage of the strategic bomber fleet. The case studies in this monograph suggest that most technological modifications are made after deficiencies are noted during campaign execution. However, wartime modifications to the strategic bomber occasionally occur in response to operational adaptations made necessary by enemy actions.

Future operational concepts for strategic bombers must account for the need to modify the employment methods during combat employment. Technological advances in aircraft design have the potential to limit the tactical and technological flexibility of Air Force planners. Air Force leadership should bear in mind that future strategic bomber design must remain flexible and open to incremental adaptation in order to accommodate deviations from the operational concept during campaign execution. The purpose of this monograph is to examine historic strategic bomber operational concepts and determine whether the Air Force had to make tactical and technological modifications to the bomber fleet in response to enemy adaptations within the operational environment.

Methodology

This monograph presents three case studies where the United States employed strategic bombers operationally during wartime and required the adaptation of strategic bombing tactics and technology. Each case study first examines pre-war doctrine, airpower theory, tactics, and technology to determine the operational concept for strategic bombers. It then examines how Air Force leaders employed the strategic bomber during the campaign to determine if Air Force leaders adhered to pre-war operational concepts during the course of campaign execution. It also examines how the Air Force adapted strategic bomber tactics and technology to enemy responses while executing operations. Lastly, it examines post-war airpower theory and doctrine to determine if adaptation during the campaign influenced the Air Force's subsequent operational concept for the strategic bomber.

The case studies focus on three historically significant campaigns involving the strategic bomber.

The first case study focuses on B-29 operations in World War II Pacific. Early airpower theorists believed that high-altitude, precision, daylight bombing (HAPDB) against industrial targets was the most effective way to break the enemy's will and win the war. Strategic bombing theory from 1920-1930 resulted in a future operational concept that led to the design requirements for the B-29. The three billion dollar B-29 program produced the most technologically advanced heavy bomber available during the era.[26] The B-29 was the perfect bomber to execute the HAPDB campaign early airpower theorists envisioned would win the war.

The second case study focuses on B-52 operations during Operation Desert Storm. General Curtis LeMay designed the B-52 during the Cold War as a high-altitude nuclear weapons delivery platform based on his experiences in World War II.[27] With its eight jet engines, the B-52 could fly at extraordinary altitudes and was a stable platform from which to deliver a large nuclear payload. Strategic Air Command assigned the majority of its B-52 bombers to nuclear alert, placing little emphasis on conventional operations. The B-52's were an integral component of the United States nuclear deterrence strategy. Despite their lack of conventional focus, B-52's performed a variety of conventional missions during Desert Storm and employed thirty-eight percent of Air Force bombs dropped during the war.

The final case study focuses on B-52, B-1, and B-2 operations during Operation Enduring Freedom from October 2001 to March 2003. The overwhelming success of the airpower campaign against Iraq in Desert Storm and Serbia in Operation Allied Force convinced airpower theorists of the primacy of airpower. The Air Force de-emphasized the role of the strategic bomber in nuclear deterrence after the Cold War and developed the bomber fleet with precision conventional weapons capability. The advent of GPS-guided weapons enhanced precision and provided all bombers with an impressive variety of conventional weapons to employ. Defense planners believed the next war would be a major combat operation against a regional power equipped with former Soviet Union weapon systems.

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[26] Carl H. Builder, *The Icarus Syndrome.* (New Brunswick, NJ: Transaction Publishers, 1996), 116.

[27] Mark D. Mandeles, *The Development of the B-52 and Jet Propulsion* (Maxwell AFB, AL: AU Press, 1998), 110.

Fundamental surprise occurred when terrorists struck in 2001 and defense planners began planning a war in Afghanistan. The campaign in Afghanistan leveraged the strategic reach of heavy bombers to overcome the challenges of conducting operations in a remote, land-locked country with few United States basing rights. The resulting campaign was not like the precision, high-altitude, daylight bombing campaign envisioned by early airpower theorists. The role of the strategic bomber had again evolved into another form, spurred on by the adaptation of technology and tactics to constraints posed by the enemy. Operation Enduring Freedom demonstrated how the technology and tactics of bombers designed during the Cold War could be successfully adapted for unconventional warfare.

Comparison of the three cases studies reveals how operational concepts for strategic bombers had to be modified in response to enemy adaptations within the operational environment. This author asserts that, in order to employ strategic bombers during a campaign, the Air Force had to modify the tactics and technologies employed by strategic bomber crews from the pre-war operational concept. Once the planners recognized the need to adapt during a campaign, flexibility in tactics and technology enabled the Air Force to modify their operational concept for successful operations. The challenge for Air Force leaders is to incorporate technological flexibility into strategic bomber design enabling them to modify their operational concept to an adaptive enemy.

Case Study 1: B-29 Operations in Japan

This case study examines the strategic bombing operational concept prior to World War II, which led to the design requirements for the B-29 bomber. Arguably, the three billion dollar B-29 bomber represented the penultimate representation of the Army Air Force's (AAF) vision for strategic bombing and its belief in the operational concept. This study outlines the AAF's strategic bombing operational concept by examining pre-war theory, doctrine, and planning and comparing it to the employment of the B-29 in the Pacific theater during WWII. It also considers how the Army Air Force modified B-29 technology and tactics during the course of campaign execution to adapt employment to the operational environment. Lastly, it examines post-war doctrine, theory, and war plans to determine if the strategic

bombing operational concept changed based on wartime experience.

Following World War I, airpower theorists gained popularity by positing that aerial warfare could be decisive making the need for committing ground forces unnecessary. The theories of William "Billy" Mitchell, Giulio Douhet, and General Hugh Trenchard were heavily influential during the interwar years. During WWI, General Hugh Trenchard began developing a strategic bombing theory, hypothesizing that bombing German sources of supply could provoke the collapse of German government and Army.[28] In *Command of the* Air, Giulio Douhet posited that there was no effective defense for aerial bombing of cities and that bombing and pursuit airplanes should be the nucleus of an air force.[29] Douhet proposed five characteristics necessary for developing a bomber aircraft: speed, radius of action, ceiling, degree of armament, and useful load.[30] Billy Mitchell, one of the leading advocates for establishing an independent United States Air Force, also recommended bomber designs based on characteristics of payload, speed, ceiling, and range.[31] Post-WWI airpower theories and bomber design characteristics heavily influenced theory and doctrine writers at the Air Corps Tactical School (ACTS), Maxwell Field, Alabama.[32]

The AAF based its concept for strategic bombing operations during WWII on theory and doctrine developed during the 1930's at ACTS. Airpower theorists at ACTS believed that the capabilities and will of an enemy could be destroyed using sustained precision attacks against the industrial infrastructure of a nation.[33] They developed these theories into an operational concept that centered on strategic bombardment of enemy industry: high-altitude, precision, daylight bombing (HAPDB) against enemy industrial and economic targets. The AAF based their operational concept on the assumption that high-

[28] Phillip Meilinger, "Trenchard and "Morale Bombing": The Evolution of Royal Air Force Doctrine Before WWII" *Journal of Military History* 60, no. 2 (April 1996), 250.

[29] Giulio Douhet, *Command of the Air*, trans by Dino Ferrari (Washington DC: Air Force Museums and History Program, 1998), 10.

[30] Ibid, 38-40.

[31] William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power – Economic and Military* (Mineola, NY: Dover Publications Inc, 1988), 186-188.

[32] James A Mowbray, "Air Force Doctrine Problems." *Airpower Journal* 4, no. 3 (Winter 1995), 3.

[33] Thomas H. Greer, *The Development of Air Doctrine in the Army Air Arm* (Washington D.C.: Office of Air Force History, 1985), 57.

altitude bombardment held the best chance for success against enemy air defenses, bombers could accurately identify and attack selected targets, and strategic bombing during daylight hours offered the greatest precision.[34]

The operational concept of HAPDB greatly influenced Captain Harold George during his attendance at ACTS and he remained after graduation to head the school's Bombardment Section.[35] As a disciple of Billy Mitchell, he began to codify strategic bombing theory by identifying and grouping specific target sets. ACTS subsequently selected Captain George as the first Director of the Department of Air Tactics.[36] He frequently lectured on the role of airpower to force enemy acquiescence and believed that the Air Force could play the primary role in war in forcing enemy submission.[37] In 1941, General "Hap" Arnold asked then Lieutenant Colonel George to lead a group of former ACTS instructors in the first Air War Plans Division to develop a plan to defeat potential enemies of the United States.[38] AWPD-1 outlined three primary target sets for destruction through strategic bombing: German electrical power, transportation system, and oil and petroleum system (refineries). Strategic bombers would target and neutralize the German Air Force enabling freedom of maneuver for bomber forces to target the enemy industrial complex.[39] This was a peculiar inclusion since an initial operative assumption was that the bomber would always get though.

One year later, President Roosevelt asked for an update to AWPD-1 based on the operational environment in Germany and Japan. The same planning division developed AWPD-42, which had a very similar approach to AWPD-1 but included a more detailed examination of Japanese strategic target sets. AWPD-42 assigned heavy bomber priorities to nine systems of targets: fighter-aircraft assembly plants,

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[34] G. Scott Gorman, *Endgame in the Pacific: Complexity, Strategy, and the B-29* (Maxwell AFB, AL: Air University Press, Feb 2000), 13.

[35]Haywood S. Hansell, *The Air Plan That Defeated Hitler* (Atlanta, GA: Higgins-McArthur, 1972), 12.

[36] Ibid., 24.

[37] Ibid., 36.

[38] Ibid., 65.

[39] Ibid., 83.

bomber aircraft assembly plants, aero-engine assembly plants, submarine yards, transportation systems, electric power systems, oil plants, aluminum plants, and synthetic rubber plants.[40] While not universally accepted, the AAF's strategic bombing campaign plan against enemy economic and industrial targets reflected the HAPDB operational concept conceived at ACTS. The preferred method for executing this campaign would be using heavily armed bombers designed with the longest range, highest cruise altitude, and most precise bomb delivery capabilities available.

The AAF developed the B-29 Superfortress concurrently with HAPDB theory. The B-29 had large engines and a pressurized crew compartment that enabled a cruising altitude of over 30,000 feet and airspeed of 300 miles per hour.[41] Large wings and fuel capacity enabled the B-29 to carry a ten-ton payload and deliver it on targets 1,500 miles away. Its twelve .50-caliber machine guns and 20mm cannon delivered formidable firepower against enemy fighters. The aircraft's design ensured the necessary stability to use the Norden bombsight, attaining remarkable accuracy in clear weather from 30,000 feet.[42] The program's three billion dollar cost made it more expensive than the Manhattan project.[43] Yet, this extraordinary price tag bought the AAF the most technologically advanced high-altitude, precision, daylight bomber available prior to WWII. The B-29 was the ultimate strategic bomber to implement a HAPDB campaign and defeat an enemy against whom AAF leaders had developed their plans.

The Army Air Force first deployed B-29s to the China-Burma-India Theater where its long range would be ideal for striking the Japanese heartland. President Roosevelt was anxious to see bombers used against Japan and AAF leaders believed that American bomber presence in China would boost the morale of the Chinese people.[44] General Arnold established the Committee of Operations Analysts (COA) in 1942 to refine the study of Japanese strategic targets. The COA identified six preferred target systems:

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[40] Ibid., 105.

[41] Lee Kennett, *A History of Strategic Bombing* (New York: Charles Scribner's Sons, 1982), 165-168.

[42] Ibid.

[43] Builder, 116.

[44] W.F. Craven and J.L. Cate, *The Army Air Forces in WWII: Volume 5, The Pacific – Matterhorn to Nagasaki, June 1944 – August 1945* (Chicago: University of Chicago Press, 1953), 17.

shipping, steel production, urban industry, aircraft manufacturing, ball bearings, and electronics.[45] The list was remarkably similar to the targets identified by the AWPD only a few months prior. General Haywood Hansell, a former ACTS instructor, AWPD planner, and lead advocate of HAPDB strategy, now commanded the XXI Bomber Command and B-29's in the Pacific Theater.

General Hansell arrived in late 1944 and began to implement a textbook HAPDB bombing campaign. Despite major logistical setbacks, the first B-29 sorties began operations against Japan in late November 1944. Unfortunately, high winds, bad weather, inaccurate radar bombing sights, and aircrew ineptitude conspired to render the first two-month's effort useless.[46] General Arnold, growing impatient with the campaign's lack of results relieved General Hansell of command in January 1945 and assigned General Curtis E. LeMay as the new commander.[47]

General LeMay understood that he would be responsible for generating immediate, effective results. While he continued HAPDB raids against aircraft plants, he also began experimenting with a new method of incendiary attack suggested by General Arnold's COA.[48] Incendiary attacks were particularly effective against the wood and paper structures, which comprised the infrastructure of Japanese cities. The wide dispersal of Japanese industry throughout urban areas complicated precision targeting. Incendiary attacks were able to destroy large sections of the city, thus wiping out major portions of industry along with the civilian populace surrounding it. Realizing the effectiveness of incendiary attacks, LeMay modified his employment methods and ordered his crews to fly night missions at low altitude. General LeMay also recognized the lack of enemy fighter defenses and stripped B-29 of defensive armaments reducing weight and enabling a higher weapons payload.[49]

The tactical adaptation paid off. On 9 March 1945, LeMay's B-29's launched the most

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[45] Ibid., 27.

[46] Curtis E. LeMay and Bill Yenne, *Superfortress: The Story of the B-29 and American Airpower* (New York: McGraw Hill, 1988), 105.

[47] Ibid.

[48] Kennett, 169.

[49] Ibid., 170

devastating air campaign of the war against the city of Tokyo.[50] The effect was immediate and had the dual outcome of destroying Japanese industry while levying a heavy psychological toll on the Japanese population. HAPDB proved ineffective in the Japanese operational environment because of bad weather and lack of target intelligence. Area bombing at low-altitude solved several of the problems that had plagued the HAPDB campaign. Weather and target identification no longer limited bomber crew's ability to destroy their targets. Despite LeMay's recognition of the limitations of HAPDB, LeMay remained an advocate and started a radar school amongst his crews to train bombardiers and improve weapons accuracy in weather at higher altitudes.[51] Yet, Bomber Command still faced the challenge of interdicting Japanese shipping.

The COA recommendations of 1944 proposed a sea- and air-blockade against Japanese shipping that included B-29 aerial mining operations.[52] AAF leadership initially resisted using B-29's for aerial mining because they did not want to divert resources from strategic bombing. Sea mining was not part of the AAF's original operational concept for strategic bombing. The AAF, under pressure from Navy leadership, relented and began working up plans for high- and low-altitude aerial mining of Japanese harbors and waterways. Initially, the AAF lacked the tactics, training, and equipment to perform this mission. Bomber Command launched a joint initiative with the Navy to develop a B-29 aerial mining program.[53] Despite lack of design consideration for an aerial mining mission, the technological and tactical flexibility of B-29 crews enabled adaption to the new role. Its radar targeting sights proved ideal for coastal mine delivery and its large payload, range, and accuracy made the B-29 and excellent platform for mine delivery. Mining operations severely restricted Japanese merchant shipping and B-29 delivered

[50] Ibid., 175.

[51] Curtis LeMay, *Strategic Air Warfare: An Interview with Generals Curtis E. LeMay, Leon W. Johnson, David A. Burchinal, and Jack J. Catton*, ed. Richard H. Kohn and Joseph P. Harahan (Washington DC: Office of Air Force History, 1988), 60.

[52] Craven and Cate, 133.

[53] Kenneth P. Werrell, *Blankets of Fire* (Washington DC: Smithsonian Institute Press, 1996), 175.

mines accounted for fifty percent of Japanese ships sunk or damaged by war's end.[54] Yet, the AAF made one more adaptation to the B-29.

The AAF began preparations for the delivery of the atomic bomb in 1943. The B-29 was the optimal platform for the atomic weapon because of its range, altitude, and payload capacity. However, the B-29 was incompatible with the atomic mission in its current configuration.[55] The AAF initiated Project Silverplate, a production run of sixty-five B-29's with modified bomb bays suitable for delivering atomic weapons.[56] Meanwhile, crews developed delivery tactics and trained for the new mission.[57] Aircrew could not use existing delivery tactics because the atomic blast shockwave would destroy a B-29 up to eight miles away.[58] Revolutionary tactics developed by specially selected crews resulted in a post-release maneuver that achieved the required eight miles of separation.[59] This was the final wartime adaptation of the B-29 as the Japanese unconditionally surrendered less than a month later.

Post-war assessments of strategic bomber performance were numerous and contentious. The United States Strategic Bombing Surveys (USSBS) were a divided effort with political factions from both the AAF and Navy attempting to control the resultant narrative.[60] These differences are evident in the division between individual reports and the summary report of the USSBS. Yet, the "Summary Report for the Pacific" concludes that, while the B-29's could have been used more effectively, the AAF did fatally reduce Japan's industrial potential leading to its eventual surrender.[61] Ultimately, the survey recommended the creation of an independent Air Service, which led to the creation of the United States

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[54] United States Strategic Bombing Survey, *Summary Report* (*Pacific War)* (July 1946; repr., Maxwell AFB, AL, Air University Press, 1987), 73.

[55] Richard H. Campbell, *The Silverplate Bombers: A History and Registry of the Enola Gay and Other B-29's Configured to Carry Atomic Bombs* (Jefferson, NC: McFarland and Co, 2005), 8.

[56] Werrell, 213.

[57] Ibid., 214.

[58] LeMay, 148.

[59] Ibid.

[60] John C. McMullen, "The United States Strategic Bombing Survey and Air Force Doctrine" (*thesis,* School of Advanced Airpower Studies, June 2001), 20-24.

[61] USSBS, *Summary Report (Pacific War)*, 112.

Air Force in 1947.[62] Despite the inter-service controversy, Air Force leaders took this as validation of their efforts and continued to develop a strategic bombing operational concept that pursued HAPDB with atomic weapons.

The Air Force did not release any official doctrine until after the Korean War, which complicates tying WWII experience with doctrine. However, the Air Force service doctrine in released in 1953 incorporated the concepts of HAPDB, industrial web theory, and the invincibility of the bomber.[63] The Air Force continued to develop radar-targeting technology to increase precision, but committed more resources to improving the destructive effects of the atomic bomb.[64] Air Force Joint War Plans of the late 1940's showed that the strategic bomber was still the centerpiece of airpower theory. War plans focused on attacking enemy industrial and economic targets with high-altitude bombers.[65] The Air Force, relying on WWII results, continued to focus on high-altitude, daylight, precision bombing of industrial targets using long-range, heavy bombers for its operational concept.

Post-WWII adaptations to the B-29 resulted in its re-designation as the B-50 Superfortress. The aircraft retained many of the same characteristics of the B-29, but had more powerful, fuel-injected engines and stronger, lighter wings enabling a cruise altitude of 35,000 feet.[66] The B-50 also retained the atomic weapons delivery capability of the Silverplate B-29s and was capable of inflight refueling extending the range of the bomber.[67] Because it retained the characteristics of the B-29, the B-50 was able to perform the same low-altitude mining and incendiary missions employed during WWII, although these missions were clearly not its focus. The Air Force incorporated advances in radar technology to mitigate the effects of weather that hampered the HAPDB campaign of WWII. The B-50 remained in the

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[62] Ibid., 119.

[63] McMullen, 40-45.

[64] Ibid., 44-45.

[65] Ibid., 45-50.

[66] Leonard Bridgman, *Jane's: All the World's Aircraft 1949-1950* (New York: McGraw-Hill Book Co, 1949), 199c-201c.

[67] Ibid.

USAF inventory until retirement in 1954.

The AAF designed the B-29 as a high-altitude, precision, daylight bomber based on the strategic bomber operational concept developed in the late 1930's. Air planners believed that they would be executing strategic bomber operations against the Japanese and that HAPDB provided the best method. The operational environment of WWII in the Pacific made executing their operational concept problematic. Air Force leaders had to modify strategic bomber tactics and technology to incorporate low-altitude incendiary attack, mining, and atomic weapon delivery to the employment methods of the B-29. These modifications required technical and tactical solutions not anticipated by pre-war planners. B-29 crews quickly learned new employment tactics through training and adaption of existing procedures. The Air Force was able to modify the technology of the B-29 because its simple, yet robust design allowed incremental development of its essential technological systems. The majority of technological improvements to the B-29 came after the war, but the AAF made several modifications to the aircraft during the war as well. The flexibility of the B-29 technology and aircrew tactics enabled the AAF to perform new and unanticipated missions despite lack of foreknowledge.

Pre-War Operational Concept for Strategic Bombers:	High-altitude, daylight, precision bombing campaign against enemy industrial and military targets
Wartime Employment Roles of B-29:	High- and low-altitude bombing
	Precision and area targeting
	Conventional, incendiary, and atomic bombs
	Sea-mining and Naval interdiction
Modification to B-29 Tactics and Technology	Low-altitude bombing
	Incendiary bombing
	Area bombing
	Sea-mining
	Atomic weapons employment
Post-War Operational Concept for Strategic Bombers:	High-altitude, all-weather, precision atomic bombing campaign against enemy industrial and military targets

Table 1: Comparison of Pre- and Post-war Operational Concepts of B-29 during WWII – Pacific Theater

Case Study 2: B-52 Operations in Operation Desert Storm

This case study examines the Air Force operational concept for strategic bombing prior to Operation Desert Storm, the role of the B-52 bomber during the campaign, and the operational concept after the campaign. The 1991 Gulf War occurred at a key moment in military history when tensions with the Soviet Union relaxed and airpower advocates reconsidered the future role of airpower in light of a new world order. Yet, the technology and tactics available to airpower planners changed little from the Cold War. During the Cold War, the B-52 played a large role in American nuclear deterrence strategy. The B-52's role during Desert Storm was dramatically different from the operational concept envisioned by airpower planners and B-52 designers.

The origins of the Air Force's pre-Desert Storm operational concept for strategic bombing are rooted in Air Force experiences after World War II. The peace treaties following World War II quickly gave way to rising tensions between the United States and the Soviet Union. In 1947, United States policy towards the Soviet Union emerged as one of "containment," but quickly shifted toward "massive retaliation" after Stalin's death and the America's discovery that the Soviets had the hydrogen bomb. [68] The existence of second-strike capability led to a policy of mutually assured destruction, mutual deterrence, and arms control by the end of the 1960's.[69] The United State's military strategy during the Cold War centered on how to deter the Soviet Union in a way that was economically feasible. The Air Force's operational concept for strategic bombing emerged from national nuclear policies towards the Soviet Union.

The dilemma of how to counter Soviet expansion and nuclear weapons resulted in President Eisenhower publishing NSC 162/2, which emphasized the need for a robust nuclear offensive striking capability.[70] This new national strategy fit perfectly with the Air Force's focus on nuclear weapons. The

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[68] Kenneth Osgood, *Total Cold War* (Lawrence, KS: University Press of Kansas, 2006), 35.

[69] Stephen J. Cimbala, *US Military Strategy and the Cold War Endgame* (Essex, England: Frank Cass, 1995), 104.

[70] Dale R. Herspring, *The Pentagon and the Presidency: Civil-Military Relations from FDR to George W. Bush* (Lawrence, KS: University Press of Kansas, 2005), 97.

Air Force published its first official doctrine, Air Force Manual (AFM) 1-2, *United States Air Force Basic Doctrine*, in April 1953, which focused on nuclear weapons and the efficacy of strategic bombing.[71] The Air Force based AFM 1-2 largely on the experiences of strategic bombing during WWII and emphasized national security policy over military history. This document focused on the employment of nuclear weapons as a means to deter aggression and provide for domestic security. The primacy of nuclear deterrence eclipsed other wartime options for employing strategic bombers in Air Force doctrine for the next ten years.

The pending United States involvement in Vietnam prompted Air Force Chief of Staff, General Curtis Lemay, to reconsider the role of conventional bombing operations. In 1964, he signed a new AFM 1-1, *United States Air Force Basic Doctrine* that emphasized new national objectives of Flexible Response and incorporated conventional weapons while retaining its emphasis on nuclear bombing.[72] The Air Force strategic bomber operational concept began to broaden towards conventional and peacetime operations, but continued to place primacy on nuclear deterrence and strategic bombing. Air Force doctrine gave little consideration to lessons learned from the Korean and Vietnam Wars and continued to mirror national strategies of nuclear deterrence.[73] Air Force doctrine would continue to perpetuate these themes until the end of the Cold War.[74]

In the meantime, there were two notable grass-roots movements in Air Force doctrine. The U.S. Army drove the first movement with their publication of FM 100-5, *Operations* in 1976 known as active defense. This Army doctrine manual was revolutionary because it acknowledged, "*the Army cannot win the land battle without the Air Force* (emphasis in original)."[75] The Army sought to establish closer ties

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[71] Johnny R. Jones, *Development of Air Force Basic Doctrine 1947-1992* (Maxwell AFB, AL: Air University Press, April, 1997), 4.

[72] Ibid., 11.

[73] Ibid., 17.

[74] Kurt Cichowski "Aerospace Doctrine Matures Through a Storm: An Analysis of the New AFM 1-1" (thesis, School of Advanced Airpower Studies, 1993), 18.

[75] U.S. Army, *FM 100-5: Operations*, 1976, 8-1.

with the Air Force and achieve coordination in five major areas: driving enemy forces from the battlefield, reconnaissance, battlefield interdiction, close-air support, and tactical airlift.[76] The Army hoped the publication of this doctrine would signal a stronger relationship between the Air Force and Army during future battles.[77]

The Army conceptualization of airpower's role in active defense formed the basis for an expanded doctrine published in 1982 as FM 100-5: *Operations*, but known as AirLand Battle.[78] The Army and Air Force formalized their cooperation with a memorandum signed at the service level in 1983.[79] While AirLand battle was never official Air Force doctrine, tactical support to the Army began to gain acceptance in the Air Force's fighter arm known as Tactical Air Command (TAC). TAC projects, such as development of the A-10 Warthog, demonstrated Air Force resolve to support Army battlefield initiatives.[80] Yet, the Commander of TAC from 1978-1984, Gen Wilbur Creech, later confessed that concessions on AirLand Battle doctrine kept the Army from taking over the close air support mission and provided the Air Force with freedom to pursue deep battle initiatives.[81]

The second grass-roots movement in Air Force doctrine also occurred largely within TAC. Colonel John Warden III wrote his book *The Air Campaign: Planning for Combat* as an attempt to return airpower theory to the roots of operational art.[82] Warden believed that there were fundamental lessons from the history of warfare that applied to air campaigns and purposefully omitted nuclear weapons and

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[76] Ibid., 8-2.

[77] Harold D. Winton, "An Ambivalent Partnership: US Army and Air Force Perspectives on Air-Ground Operations, 1973-90" in *Paths of Heaven,* ed. Phillip S. Meilinger (School of Advanced Airpower Studies, 1997), 416.

[78] Ibid., 420.

[79] Ibid.

[80] Ibid., 409.

[81] John A. Olsen, *John Warden and the Renaissance of American Air Power* (Washington DC: Potomac Books, 2007), 103.

[82] Ibid., 64.

space in order to understand how the Air Force should prosecute a conventional air campaign.[83] Warden viewed AirLand Battle as a way for the Army to dictate terms of a campaign and limit the Air Force to a supporting role.[84] He believed that single arms could prevail in combat and that airpower could theoretically win the war.[85] Warden eventually became head of the Air Force Doctrine Division and undertook a complete revision of AFM 1-1 to incorporate his ideas of operational art, which was not released until 1992.[86] Many of Warden's ideas were influential in the Desert Storm air campaign and contributed to the Air Force adopting the operational concept of Global Power - Global Reach, published by the Secretary of the Air Force.[87]

Secretary of the Air Force Donald B. Rice released his white paper titled "The Air Force and US National Security – Global Reach, Global Power" in June 1990. Published only months before Iraq invaded Kuwait; the white paper represented a shift in thinking about American defense, national strategy, and the role of strategic bombers. The need for American nuclear deterrence retained primacy, but airpower theorists began to consider publicly the evolution of the strategic bomber's role in a post-Cold War security environment.[88] The Air Force planned to use bombers for nuclear deterrence, but the bomber would also be critical in projecting long-range power with precision munitions. It read:
"The bomber's long range means that the United States can project power and enhance presence in a very short time - and often at lower cost relative to other options - regardless of conflict location. In the Persian Gulf area or deep in other theaters, long-range bombers can threaten or hit targets in the crucial first hours or early days of a conflict. They may be the only assets capable of doing so."[89]

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[83] John A. Warden, *The Air Campaign: Planning for Combat* (Washington DC: National Defense University Press, 1988), xvii.

[84] Olsen, 65.

[85] Warden, 39.

[86] Olsen, 119.

[87] Ibid., 135.

[88] Secretary of the Air Force, *The Air Force and US National Security – Global Power, Global Reach* by Donald B. Rice (Washington DC: Government Printing Office, June 1990), 4.

[89] Ibid., 8.

The Global Power, Global Reach white paper also envisioned using bombers in conjunction with carrier-based aircraft for sea mining operations and for anti-shipping capabilities.[90] In short, the strategic bomber operational concept expanded from nuclear deterrence and strategic bombing during the 1980's to conventional bombing and long-range coercion during the 1990's. Peacetime shifts in national strategy and policy led to progressive modification of the strategic bombing operational concept and shifted bomber crew tactics and B-52 technology.

The design requirements for the B-52 originated in the wartime experiences of the AAF. General Curtis E. LeMay designated the requirements for the B-52, which focused primarily on atomic weapons delivery while discounting its role in conventional bombing (although it did have a conventional capability).[91] The B-52's modern jet engines and aerodynamics gave it impressive speed, ceiling, radius of action, and payload. The B-52's speed and altitude meant fighter intercepts were limited to rear aspect approaches for which the B-52 maintained a tail-mounted anti-aircraft gun. Ground based anti-aircraft weapons posed an increasing threat, for which the B-52 was equipped with an electronic-based countermeasure system designed to confuse enemy radar and targeting capability. The B-52 remained the centerpiece for nuclear deterrence of the strategic bomber fleet for thirty years. Yet, during the 1950's, the Air Force began to recognize the growing threat posed by Soviet defenses.[92]

Soviet air defenses became increasingly effective at high-altitude, which called into question the efficacy of high-altitude precision bombing.[93] During the early 1960's, the B-52 underwent an extensive modification program to enhance its low-altitude nuclear delivery capabilities.[94] However, Air Force

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[90] Ibid., 10.

[91] Mark D. Mandeles, *The Development of the B-52 and Jet Propulsion* (Maxwell AFB: Air University Press, 1998), 110.

[92] Michael E. Brown, *Flying Blind: The Politics of the Strategic Bomber Program* (Ithaca, NY: Cornell University Press, 1992), 234.

[93] Bill Yenne, *SAC: A Primer of Modern Strategic Airpower* (Novato, CA: Presidio Press, 1985), 77.

[94] Bill Gunston, *Bombers of the West* (London: Allan, 1973), 174. *See also* Robin Cross, *The Bombers: The Illustrated Story of Offensive Strategy and Tactics in the Twentieth Century* (New York: MacMillen Publishing Company, 1987), 194.

leaders optimized B-52 design for high-altitude performance and its effectiveness at low altitude was limited.[95] The development of a Soviet fighter lookdown, shoot-down capability and the cancellation of the B-1 bomber program in 1977 reduced the Air Force's capability to penetrate Soviet airspace using low-altitude tactics. Therefore, the Air Force began development of the Air-Launched Cruise Missile (ALCM).[96] The range and nuclear delivery capability of the ALCM meant the vulnerable B-52, with its large radar cross section, could attack targets while remaining outside of defended airspace. Multiple ALCM's could saturate enemy defenses and ensure that American weapons hit their targets. The technology of the ALCM led to the development of the Conventional Air-Launched Cruise Missile (CALCM), which fired the opening salvo of the Desert Storm air campaign.

The Air Force designed the B-52 as a high-altitude, precision, all-weather bomber for delivering nuclear weapons. While the nuclear mission was a primary consideration in B-52 design, the Air Force initiated two modification programs in 1964-1965 to enhance B-52 conventional delivery capabilities in anticipation of a conflict with Vietnam. [97] General LeMay authorized the modification of B-52D and B-52F models known as the "big belly modification." This modification enabled the B-52 to carry 70,000 pounds of conventional munitions.[98] Throughout its service, enemy adaptations influenced the Air Force operational concept for strategic bombing. The B-52 operational concept evolved through several stages including high-altitude nuclear weapon delivery, low-altitude nuclear weapons delivery, high-altitude conventional weapons in Vietnam, standoff employment of nuclear cruise missiles, maritime anti-shipping operations, and low-level conventional strike. The flexibility of the B-52 design enabled the Air Force to modify the aircraft and tactics for these operational concepts.

The B-52's that served in Operation Desert Storm were capable of performing all Air Force

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[95] Brown, 237.

[96] Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell AFB, AL: AU Press, 1998), 178.

[97] Norman Polmar, *Strategic Air Command: People, Aircraft, and Missiles* (Annapolis, MD: The Nautical and Aviation Publishing Company, 1979), 96.

[98] Thomas C. Hone, "Strategic Bombardment Constrained: Korea and Vietnam" in *Case Studies in Strategic Bombardment,* ed. R. Cargill Hall (Washington DC: Air Force History and Museums Program, 1998), 496.

missions except one: delivering precision laser-guided bombs. The B-52G's could release fifty-one 500-lbs bombs, conduct anti-shipping operations, and launch CALCM's, which were its only guided weapons. B-52 crews relied on offensive avionic computers, internal navigation systems, and ground mapping radar to determine the ballistic release point for its bombs. Ironically, the Air Force commissioned the Boeing Company in 1982 to conduct a study for the use of precision guided munitions by B-52's for conventional long-range strike. Boeing examined precision standoff missiles against three conventional scenarios, one of which was Iraq invading Kuwait and Saudi Arabia.[99] They calculated eighteen B-52's would be necessary to slow Iraqi advance until the Rapid Deployment Joint Task Force could arrive.[100] However, the Air Force never integrated the capability for precision strike prior to Operation Desert Storm.

Lack of laser-guided munitions hampered effectiveness against single-point targets. Air planners could not use B-52's to strike urban targets because of high collateral damage concerns. Therefore, air planners used B-52's to strike area targets, such as airfields, troop concentrations, manufacturing facilities, and targets in the open desert. The lack of technological flexibility in the B-52 weapon options limited the number of targets that B-52's could effectively destroy. This limitation would alter the way Air Force planners developed their strategic bomber employment methods for targeting in Desert Storm.

Although America had some warning of a possible Iraqi strike, United States Central Command (CENTCOM) had few resources in the region to respond. As Cold War tensions began to ease, CENTCOM military planning shifted from a Soviet-based threat to regional threats from state-actors, such as Iraq.[101] The Air Force Global Power White Paper of 1990 referred to the possibility of a regional threat to Persian Gulf oil supplies but did not commit additional resources.[102] In the spring of 1990,

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[99] Thomas A. Keaney, "Strategic Bombers and Conventional Weapons: Airpower Options" in *National Security Affairs Monograph Series* (Washington DC: National Defense University Press, 1984), 53.

[100] Ibid., 54.

[101] Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey: Summary Report* (Washington DC: Government Printing Office, 1993), 21.

[102] Secretary of the Air Force, *The Air Force and US National Security – Global Power, Global Reach* by Donald B. Rice (Washington DC: Government Printing Office, June 1990), 2.

CENTCOM prepared a draft operations plan titled OPLAN 1002-90, Defense of the Arabian Peninsula in preparation for a regional threat.[103] The threat materialized when the Iraqi Republican Guard invaded Kuwait on August 2, 1990. A few weeks later, President Bush released National Security Directive 45, which outlined United States grand strategy to coordinate instruments of national power and "defend its vital interests in the area."[104] The document outlined strategic objectives for Iraq consisting of the immediate, complete, and unconditional withdrawal of all Iraqi forces from Kuwait, restoration of Kuwait's legitimate government, security and stability in the Persian Gulf, and protection of American citizens abroad.[105] The United States and its Allies began Operation Desert Shield to build forces in the region and prevent expansion of Iraqi aggression into Saudi Arabia. The Air Force deployed twenty B-52G aircraft to the region. By early February 1991, this number increased to sixty-six bombers available to air planners for tasking.

On January 16, 1991, B-52G bombers from Barksdale Air Force Base, Louisiana became the first aircraft launched in the Desert Storm air campaign.[106] These bombers launched their Conventional Air-Launched Cruise Missiles against Iraqi telecommunications and electrical infrastructure on January 17th.[107] On the same day, B-52G's from Diego Garcia conducted low-level conventional bombing runs against Iraqi airfields and runways and struck the Tawakalna Division of the Republican Guard.[108] B-52's continued low-altitude operations for the first three days of the war before CENTCOM directed a switch to

[103] Keaney and Cohen, 21.

[104] White House, *National Security Directive 45: US Policy in Response to the Iraqi Invasion of Kuwait* (Washington DC: August 20, 1991), 1.

[105] Ibid., 2.

[106] Richard P. Hallion, *The Storm Over Iraq: Air Power and the Gulf War* (Washington DC: Smithsonian Institution Press, 1992), 163.

[107] Gulf War Airpower Survey *Volume 2: Part A: Operations* (Washington DC: Government Printing Office, 1993), 322.

[108] Richard G Davis, *Decisive Force: Strategic Bombing in the Gulf War*, (Air Force History and Museums Program, 1996), 36. *See also* Gulf War Airpower Survey, *Volume 2: Part 1: Operations* (Washington DC: Government Printing Office, 1993), 327.

high-altitude bombing.[109] When the war commenced, planners were uncertain how high the risk would be from enemy air defenses and fighter aircraft. The first three days bombing campaign drastically reduced the air defense threat to coalition aircraft. CENTCOM leadership believed the threat of ground collisions and small arms fire was greater than employing strike aircraft from higher altitude and directed all United States military aircraft to conduct bombing missions from 15,000' or higher.[110]

The decision to bomb from high-altitude caused a drastic shift in B-52's employment methods. Prior to Desert Storm, SAC crews trained to bomb at low-altitude and had limited exposure to high-altitude formation bombing.[111] Additionally, B-52's deployed to theater with plenty of M117 General Purpose Bombs, but only brought high-drag tail fins designed for use at low altitude. The Air Force had to airlift tail fins appropriate for high-altitude bombing to prevent running out of bombs.[112] CENTCOM's decision to switch from low-altitude to high-altitude bombing required bomber crews to modify their tactics.

This change in tactics had second-order effects to bomber targeting. Higher employment altitudes meant decreased accuracy because of winds and ballistic trajectory errors of unguided weapons. The B-52's wide pattern of bomb distribution proved better suited to targets such as airfields, weapons manufacturing and storage facilities, and troop concentrations.[113] Air planners focused the B-52 on area targets including: command and control, electrical facilities, kill box (fielded forces), lines of communication (interdiction), military/industrial bases, nuclear, biological, chemical, offensive

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[109] Gulf War Airpower Survey, *Volume 2: Part 2: Effects and Effectiveness* (Washington DC: Government Printing Office, 1993), 144.

[110] Keaney and Cohen, 16.

[111] United States General Accounting Office, *Operation Desert Storm: Limits on the Role and Performance of B-52 Bombers in Conventional Conflicts* GAO/NSAID-93-138 (Washington DC: Government Printing Office, May 1993), 5.

[112] James A. Winnefield, Preston Niblack, and Dana J. Johnson, *A League of Airman: US Airpower in the Gulf War* (Santa Monica, CA: RAND, 1994), 233.

[113] Gulf War Airpower Survey, *Volume 4: Part 1: Weapons, Tactics, and Training* (Washington DC: Government Printing Office, 1993), 90.

counterair, and Scud missiles.[114] Nearly all missions assigned to B-52 aircrew during Desert Storm were mission categories attributed to the B-52 prior to the air campaign.[115] Yet, the majority of taskings assigned to B-52 crews were against fielded forces.[116] General Schwarzkopf often used B-52's against Iraqi front lines and opposed using B-52's outside the Kuwaiti theater.[117] He demanded B-52's hit the Republican Guard every three hours for the duration of the war, which had a punishing psychological effect against the enemy.[118] General Schwarzkopf played a large role in determining employment methods for strategic bombers once they arrived in theater.

Post-war analysis of the air-to-ground campaign revealed a peculiar shift in roles between TAC and SAC. Air planners considered eight of the twelve target categories to be "strategic" including, command and control, leadership, nuclear, chemical, and biological facilities, military support facilities, ballistic missile capabilities, electric power, oil refineries, and highway and railroad bridges.[119] Non-strategic target categories included attack of surface forces and air control.[120] Aside from cruise missile strikes on January 17, 1991, air planners mainly focused B-52 targeting on Iraqi fielded forces, battlefield interdiction, and destruction of enemy airfields. Less than one in six bombs released by the B-52 was against targets designated by war planners as strategic, which is inconsistent with the pre-war operational concept.[121] Fighter-bombers, such as the F-117, F-15E, and F-111F, performed the majority of strike against targets designated as strategic by air planners. The F-117 flew two percent of the sorties in the air

[114]United States General Accounting Office, *Operation Desert Storm: Evaluation of the Air Campaign* GAO/NSIAD-97-134 (Washington DC: Government Printing Office, June 1997), 77.

[115] GAO/NSIAD-97-134, 65.

[116] Gulf War Airpower Survey, *Volume 4: Part 1: Weapons, Tactics, and Training* (Washington DC: Government Printing Office, 1993), 166.

[117] Keaney and Cohen, 37.

[118] Davis, 39.

[119] Keaney and Cohen, 64.

[120] Ibid., 65.

[121] Davis, 40.

campaign, yet struck forty percent of strategic targets during Desert Storm.[122] Several factors during the conflict influenced B-52 targeting assignments including: collateral damage concerns, lack of battle damage assessment, lack of integration into the tasking cycle, and specific requirements of General Schwarzkopf.

Although post-war analysis noted some deficiencies, the Desert Storm air campaign was widely considered a successful example of what airpower could accomplish and validated pre-war airpower thought. Strategic Air Command released a "Bomber Roadmap" in June 1992 calling for increased role of strategic bombers in conventional operations.[123] The Air Force released AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, which was a "significant departure from the earlier manuals" using operational art to connect airpower to the nature of war.[124] Secretary of the Air Force Rice rewrote his "Global Reach-Global Power" white paper based on experiences in Desert Storm, which de-emphasized the nuclear deterrence role of the strategic bomber, promoted elimination of the strategic and tactical distinctions between airframes, enhanced the status of precision guided munitions, and promoted airpower as decisive.[125] President Bush ordered the termination of nuclear alert and the stand down of nuclear forces on September 27, 1991.[126] Most significantly, TAC and SAC merged into a new organization called Air Combat Command, which had the responsibility of coordinating the actions of all combat aircraft.

Differentiating the influence of the Desert Storm air campaign and the end of the Cold War on these events is impossible. However, events that occurred in the early 1990's had a dramatic effect on the Air Force's operational concept for the strategic bomber. Air Force Chief of Staff General Merrill

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[122] Ibid.

[123] GAO/NSAID 93-138, 2.

[124] Jones, 31.

[125] Secretary of the Air Force, *Global Reach-Global Power: The Evolving Air Force Contribution to National Security* by Donald B. Rice, (Washington DC: Government Printing Office, December 1992), 11.

[126] Daniel L. Haulman, *One Hundred Years of Flight: USAF Chronology of Significant Air and Space Events 1903-2003* (Maxwell AFB, AL: Air University Press, 2003), 140.

McPeak commented that the top two lessons learned from the Gulf War were the revolutionary impact of stealth and the importance of precision weapons.[127] While B-52 bombers delivered thirty-seven percent of the total bomb tonnage during the Gulf War, the post-war emphasis was on the contribution of precision weapons to the battlefield.[128] SAC's 1992 Bomber Roadmap equipped all three strategic bombers with precision munitions, developed the conventional capability of the B-1, and shifted the primary role of the B-2 to a conventional mission.[129] During this period, the differentiation between strategic and tactical targets began to blur. The designation of targets as strategic originated during World War II. At the time, heavy bombers were one of the only ways the United States military could bypass fielded forces to attack enemy leadership and industry.[130] Advances in aircraft range and air refueling enabled fighter-bombers to attack targets across Iraq. After Desert Storm, General McPeak said, "the difference between strategic and tactical is fuzzy," elaborating that aircraft of all types could reach targets across the theater.[131]

In the aftermath of the Gulf War, the operational concept for strategic bombers changed from nuclear deterrence to precision conventional operations. The Air Force used the strategic bomber to provide crisis response by holding enemy targets at risk anywhere in the world. In 1996, the Department of Defense employed bombers during combat, using B-52's to launch cruise missiles into Iraq during Operation Desert Strike. In 1998, the Air Force again used bombers against Iraq during Operation Desert Fox, where B-52's launched cruise missile and the B-1 made its combat debut.[132] Air Force planners used all three strategic bombers during Operation Allied Force in 1999, which was the first use of the B-2

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[127] Merrill A. McPeak, "Airpower: Lessons Learned from Desert Storm" in *Selected Works: 1990-1994* (Maxwell AFB, AL: Air University Press, 1995), 223.

[128] GAO/NSIAD-97-134, 70.

[129] United States General Accounting Office, *Strategic Bombers: Adding Conventional Capabilities Will be Complex, Time-Consuming, and Costly* GAO/NSIAD-93-45 (Washington DC: Government Printing Office, February 1993), 3.

[130] Lemay, 19.

[131] McPeak, 10.

[132] Haulman, 150.

bomber in combat.[133] During the 1990's, the Air Force no longer limited strategic bombers to attacking targets sets identified as strategic. Instead, air planners used aircraft with the weapons capabilities best suited to create the necessary effect against nominated target sets.

CENTCOM deviated from the Air Force's pre-war operational concept while employing the B-52 during Operation Desert Storm. The Air Force developed the B-52 as an all-weather, high-altitude precision bomber to deliver nuclear weapons. Throughout the B-52's service life, the Air Force modified its operational concept requiring the modification of tactics and technology. The operational concept prior to Operation Desert Storm included nuclear deterrence and global conventional power projection. However, the Air Force needed the conventional delivery capabilities of the B-52 to provide battlefield air interdiction and close-air support for ground troops deployed to theater. Air planners used the B-52's standoff capabilities on the first day only, thereafter preferring more precise tactical aircraft against strategic targets.

B-52's began the bombing campaign using low-altitude weapons delivery for the first three days before deciding that the tactic was too risky and switching to high-altitude weapons delivery. Bomber crews had to modify their tactics and re-learn the necessary procedures for high-altitude formation bombing. Bomber crews, accustomed to having preplanned targets, modified their tactics and switched targets inflight due to the developing enemy situation. While, the forty-two day air campaign did not incorporate many changes to technology, post-war changes to the strategic bomber operational concept required the integration of GPS technology and laser-guided weapons capabilities. Tactical and technological flexibility enabled the Air Force to modify and adapt the B-52 to the new operational concept.

The operational concept for strategic bombers during the 1980's envisioned using bombers for nuclear deterrence and long-range attack of enemy strategic targets. Air planners during Desert Storm did use strategic bombers for that purpose, but also used them to attack surface forces and air fields. Prior to

[133] Ibid., 154.

the war, strategic bombers were the primary means of executing strategic attack. As the lines between strategic and tactical targets began to blur, air planners found a more effective use of B-52's against enemy fielded forces. Bomber crews had to modify their tactics to accommodate changes to employment methods for bomber aircraft.

Pre-Desert Storm Operational Concept for Strategic Bombers:	Nuclear deterrence and long-range conventional attack of enemy military and infrastructure
Desert Storm Employment Roles of B-52:	High- and low-altitude bombing
	Precision and area targeting
	Conventional bombing and land mining
	Standoff cruise missile attack
	Battlefield air interdiction
	Close air support
Modification to B-52 Tactics and Technology	High-altitude bombing
	Battlefield Air Interdiction
	On call targeting
	Precision Weapons
	Global Positioning System
Post-Desert Storm Operational Concept for Strategic Bombers:	Long-range conventional attack using precision munitions and nuclear deterrence

Table 2: Comparison of Pre- and Post-war Operational Concepts for B-52 during Desert Storm

Case Study 3: Strategic Bombers in Operation Enduring Freedom

This case study examines strategic bomber operations in Operation Enduring Freedom from October 2001 until April 2003. Defense planners used all three US strategic bombers, the B-1, B-52, and B-2, in Operation Enduring Freedom in a combined arms effort to eliminate Taliban influence in Afghanistan. This case study examines the role of the strategic bomber in contemporary security and how the Air Force modified the tactics and technology of strategic bombers to fit the operational environment. The technology and tactics employed by strategic bomber crews played a large role in shaping the employment methods during the campaign. Although strategic bombers continue to perform operations in Afghanistan in 2010, this monograph limits its examination of bomber operations from October 2001 to April 2003. After 2003, the Air Force reduced bomber presence in Afghanistan, having accomplished initial United States strategic objectives and begun to shift focus to Iraq.

The Air Force's operational concept for strategic bombers emerged from the Cold War and the Gulf War considerably changed. In 1992, the primary mission of the B-2 bomber changed from nuclear to conventional employment and the B-1B lost its nuclear role, becoming a conventional only bomber.[134] The Air Force bomber modernization program incorporated precision guided munitions and emphasized conventional munitions capability.[135] The operational concept for strategic bombers provided defense planners with rapid response capabilities for global crises.

The Air Force made drastic changes to the peacetime operational concept for the strategic bomber fleet after the Cold War that resulted in numerous modification programs. In addition to restructuring the B-1B to a conventional-only role, the Air Force retired all of its B-52G model aircraft used in conventional operations during Desert Storm opting to retain only the newer B-52H aircraft. The Air Force upgraded all bombers with Global Positioning System (GPS) to improve accuracy and Military Standard 1760 weapons-to-aircraft electronic interface.[136] This modification enabled bombers to employ guided weapons such as the GPS-guided Joint Direct Attack Munition (JDAM), Wind Corrected Munitions Dispenser (WCMD), and Joint Standoff Weapon (JSOW). Additionally, B-52 crews modified their tactics to release laser-guided bombs such as the GBU-10 and GBU-12.

The upgrades in technology and modification of tactics became part of the Air Force's strategic bomber operational concept preceding Operation Enduring Freedom. The 1999 United States Air Force White Paper on Long Range Bombers, also known as the Bomber Roadmap, outlined this operational concept. This included conventional and nuclear deterrence, stalling enemy operations during the opening phases of a campaign, strategic attack of enemy infrastructure, using standoff or stealth to operate autonomously, and leveraging heavy firepower in sustained operations.[137] The Air Force viewed

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[134] GAO/NSIAD-96-192, 26.

[135] Ibid., 24.

[136] GAO/NSIAD-93-45, 36.

[137] U.S. Air Force, *US Air Force White Paper on Long Range Bombers* (Washington DC: Government Printing Office, 1 March 1999), 14.

strategic bombers as a long-range platform capable of responding to worldwide targeting requirements, employing precision weapons, fusing sensor data with communications, and attacking targets in all Air Force mission areas of strategic attack, offensive counterair, counterland, and countersea.[138]

In 2000, the Department of Defense released a report to Congress outlining the defense strategy of the United States and its operational concept for defense. The report asserts that the Air Force would use bombers as a rapid-response weapon arriving early to a conflict with large firepower to stall enemy actions and react early to a crisis.[139] The Department of Defense planned to use strategic bombers for global attack and precision engagement, which meant striking remote targets across the spectrum of conflict.[140] With remarkable prescience, the report stated, "for remote inland targets, bombers could be the only weapons platform capable of providing a substantial response."[141] The Air Force's future operational concept for strategic bombers included attacking remote targets from long distance using precision and standoff weapons. Bomber crews had some experience with inflight retargeting, but very little experience with close air support.

The Department of Defense had three bombers with which to apply their operational concept. The oldest was the B-52, which had been the workhorse strategic bomber since the early 1960's. As outlined in the previous case study, the Air Force designed the B-52 for delivering high-altitude nuclear weapons against strategic targets and the B-52 had spent most of its operational time on nuclear alert. However, the B-52 had seen the most combat of any strategic bombers, employing conventional weapons in Vietnam, Iraq, and Kosovo. The B-52 was also capable of employing air-launched cruise missiles, laser-guided bombs, and unguided munitions. The B-52's ability to self-acquire targets was limited by its sensor technology and it had to receive targets externally via radio or satellite radio.

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[138] Ibid.,18.

[139] Secretary of Defense, *Annual Report to the President and Congress* by William Cohen (Washington DC: Government Printing Office, 2000), 44.

[140] Ibid., 200.

[141] Ibid., 44.

The B-1B Lancer's reduced radar cross section and high speed optimized its ability to deliver weapons in a low- to medium-threat air defense environment. The concept for the B-1 originated in 1961 after the cancellation of the XB-70 program.[142] As Soviet air defense technology improved, the Air Force began to question the ability of current bombers to penetrate Soviet Union airspace and deliver ordinance. The Advanced Manned Strategic Aircraft program studied the concept of using a high-speed, low-altitude penetrator that would be more successful evading air defenses.[143] Escalating costs, production delays, and technical problems led President Carter to cancel the program in 1977.[144] President Reagan resurrected the program in 1981 and the Air Force redesigned the B-1A by sacrificing high-altitude supersonic performance for optimized low-altitude characteristics and reduced radar cross section.[145] The Air Force designed the B-1B primarily as a nuclear bomber and it could employ only one type of conventional bomb, which led to costly upgrade programs during the 1990's to enhance conventional capabilities.[146]

In 1981, President Reagan also revealed his intent to develop a strategic bomber with stealth characteristics for fielding in the 1990's.[147] Soviet air defense capabilities had steadily improved and the Air Force estimated that they would render existing strategic bomber nuclear delivery capabilities obsolete by mid-1990.[148] The Air Force wanted a strategic bomber capable of penetrating enemy air defenses autonomously with impressive range and payload capabilities. The B-2A Spirit began flight-testing in the 1989 with an initial plan to field 132 aircraft.[149] The end of the Cold War, production delays,

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[142] Bill Gunston, *Bombers of the West* (New York: Charles Scribner's Sons, 1973), 262.

[143] Ibid., 270.

[144] Michael E. Brown, *Flying Blind* (Ithaca, NY: Cornell University Press, 1992), 263.

[145] Robert F. Futrell, *Ideas, Concepts, and Doctrine: Basic Thinking in the United States Air Force 1961-1984* (Maxwell AFB, AL: Air University Press, 1989), 373.

[146] GAO/NSIAD-93-45, 18.

[147] Futrell, 369.

[148] Bill Scott, *Inside the Stealth Bomber: The B-2 Story* (Blue Ridge Summit, PA: Tab AERO Books, 1991), 5.

[149] Brown, 300.

and cost overruns caused congress to limit B-2 production to twenty aircraft.[150] When the Air Force finally fielded the B-2, nuclear alert had gone away and the Air Force modified its primary mission to precision employment of conventional weapons.[151] The B-2's first combat employment occurred in 1999 during Operation Allied Force, where it struck targets in Serbia from its home base at Whiteman AFB, Missouri using a variety of munitions, including GPS-guided JDAM.[152]

After the attacks on September 11, 2001, political and military leadership designed a strategy to destroy al Qaeda infrastructure and senior leadership in Afghanistan.[153] Officials at CENTCOM determined three objectives: bring down the Taliban regime, destroy al Qaeda's base of operations, and hunt down bin Laden and other high-level al Qaeda leadership.[154] To accomplish these objectives, CENTCOM's operational concept employed bombers with precision guided munitions, special operations forces, and Central Intelligence Agency paramilitary operatives working with Afghan resistance forces.[155]

On September 19, 2001, B-52 and B-1 bombers deployed to Diego Garcia to stage operations into Afghanistan. United States officials had difficulty obtaining foreign basing rights, which limited initial air operations to strategic bombers and Navy carrier aircraft. The first phase of operations targeted Taliban infrastructure using strategic bombers and carrier-based aircraft, in concert with the pre-war strategic bomber concept. Strategic bombers used a mix of JDAM and unguided weapons to destroy air defenses, attack Taliban and al Qaeda leadership, and destroy enemy infrastructure.[156] The B-2's flew for the first two days of the war and ceased operations after having destroyed Afghan air defense systems.[157] This left the B-52 and B-1's as the sole bombers to support theater objectives. After ten days of bombing, United

[150] Ibid, 302. *See also* GAO/NSIAD-96-192, 20.

[151] GAO/NSIAD-96-192, 42.

[152] Haulman, 154.

[153] Benjamin S. Lambeth, *Airpower Against Terror: America's Conduct of Operation Enduring Freedom* (Santa Monica, CA: National Defense Research Institute, 2005), 43.

[154] Ibid., 59.

[155] Ibid., 60.

[156] Ibid.,83.

[157] Rebecca Grant, *The Afghan Air War* (Arlington, VA: Aerospace Education Foundation, 2002), 13.

States aircraft destroyed all preplanned, fixed targets and transitioned to direct attack against Taliban and al Qaeda forces.[158]

B-52 and B-1 bombers began to take off without pre-designated targets, relying on ground forces to provide targets via radio.[159] This shift in targeting methodology signaled a change in operations for strategic bombers since crews had little training to perform close-air support.[160] By December, the Taliban fled power and targeting missions shifted to destroying remaining al Qaeda and Taliban officials and forces.[161] The U.S. Army made a concerted push during Operation Anaconda, which was the largest ground engagement of the war.[162] Throughout this period, CENTCOM used strategic bombers for on-call close air support and show of force demonstrations to intimidate or eliminate enemy forces. With the exception of Operation Mongoose in February 2003, the majority of strategic bomber missions did not release munitions after Operation Anaconda. Bomber crews orbited over ground forces awaiting targets and typically returning with munitions. The commencement of Operation Iraqi Freedom absorbed available bomber missions and, although bombers continue to fly in Afghanistan in 2010, large-scale combat employment was over.

Operation Enduring Freedom represented the first combat employment of GPS-guided weapons by all strategic bombers, which released 70% of the total expended munitions in Afghanistan.[163] Strategic bomber missions were highly valued by ground forces because of their high payload capacity and battlefield persistence, which allowed enabled continuous close air support. Following Enduring Freedom, the Air Force implemented several upgrade programs to enhance the precision weapon capabilities of strategic bombers. These programs centered on enhancing sensor technology to find

[158] Lambeth, 93.

[159] Ibid., 94.

[160] Operational Leadership Experiences, *Interview with Major Mike Adderley* (Fort Leavenworth, KS: Combat Studies Institute, 2005), 4.

[161] Lambeth, 149.

[162] Ibid., 199.

[163] Ibid., 253.

targets, expanding communications abilities, automating the targeting process with ground forces, and expanding the number and mix of guided weapons that bomber aircraft could carry. By December 2003, the Air Force had integrated Litening Pod targeting sensors on B-52 aircraft, which could now employ self-designated laser-guided weapons.[164] By 2009, the Air Force had integrated Sniper pod to both its B-1 and B-52 bomber aircraft providing unprecedented ability to acquire targets on the battlefield.[165] The B-2 bomber received upgrades to communication equipment and datalink capabilities.[166] Additionally, the Air Force awarded contracts to upgrade the radar on its entire strategic bomber fleet, improving ability to detect and track targets. [167] Lastly, the Air Force began a complete overhaul of B-52 communication systems, which enhanced its conventional mission and ability to conduct close air support.[168]

The end of the Cold War and the experience in Desert Storm influenced thought within the Air Force on the future of strategic bombing. The strategic bombing operational concept evolved from the primacy of nuclear deterrence to conventional long-range strike with precision munitions. The Air Force used strategic bombers for deterrence and coercion, employing bombers for this purpose three times during the 1990's. The Air Force envisioned future enemies as regional powers equipped with former-

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[164] Air Force Print News, "B-52 Litening Pod II Used in Combat" Air Force Web site, April 12, 2003, online at http://www.globalsecurity.org/military/ library/news/2003/04/mil-030412-afpn02.htm, (accessed January 17, 2010).

[165] SSgt Mathew Bates, "Sniper Pod Improves Capabilities, Lethality of B-1," *Air Force News*, online at http://www.af.mil/news/story.asp?id=123140611 (accessed January 17, 2010). *See also* Boeing Co. News Release, "Boeing Awarded Contract for B-52 Advanced Targeting," Boeing Web site, 24 September 2008, online at http://www.boeing.com/news/releases/2008/q3/080924b_nr.html (accessed October 15, 2008).

[166] Air Force News Service, "Air Force Not Being Stealth About Upgrading B-2 Fleet" Air Force Web site, January 2, 2007, online at http://www.af.mil/news/story.asp?id=123036531 (accessed January 17, 2010).

[167] Boeing Co. News Release, "Boeing Awarded Contract to Upgrade B-1 Bomber Radar" Boeing Web site, April 20, 2006, online at http://www.boeing.com/defense-space/military/b1-lancer/news/2006/q2/060420a_nr.html (accessed January 17, 2009). *See also* Air Force News Service, "B-2 Radar Modernization Program Contract Awarded," Air Force Web site, December 20, 2008, online at http://www.af.mil/news/story.asp?id=123129776 (accessed January 17, 2010) *and* Department of Defense, "B-52 Research, Development, Test and Evaluation Budget," *Research and Development Descriptive Summaries*, online at http://www.dtic.mil/descriptivesum/Y2010/AirForce/0101113F.pdf, (accessed January 17, 2010).

[168] Department of Defense. "B-52 Research, Development, Test and Evaluation Budget" *Research and Development Descriptive Summaries*, online at http://www.dtic.mil/descriptivesum/Y2010/AirForce/0101113F.pdf, (accessed January 17, 2010).

Soviet military hardware, similar to the enemies faced in Operations Desert Storm and Allied Force. CENTCOM did not have plans for a regime change in Afghanistan as this scenario seemed unlikely. However, when this task became necessary, CENTCOM used bombers in a manner somewhat consistent with the Air Force's operational concept. Using strategic bombers for on-call close air support and policing actions required tactical adaptation, but was ultimately successful. The long reach, large payload, precision strike capability, and battlefield persistence made the strategic bomber an integral component of operations in Afghanistan.

Ultimately, the Air Force incorporated battlefield persistence and direct support to ground forces as new capabilities in their strategic bombing operational concept. Operation Enduring Freedom provided the final example of how the Air Force modified their strategic bomber operational concept through tactics and technology. Prior to the war, the Air Force operational concept was for bombers to provide global conventional power projection in response to enemy aggression. The Air Force designated the strategic bomber for conventional and nuclear deterrence against a major nation state armed with former-Soviet Union weaponry. During Operation Enduring Freedom, the strategic bombing campaign ended after bombers destroyed all strategic targets within a few days. Ground forces needed the strategic bombers to provide airpower for coalition operations. Bomber crews modified their tactics and used existing technology to modify their employment methods and provide on-call close air support for ground forces. After the war, the Air Force modified the sensor and communications technology of the bomber fleet to fit the new mission.

Pre-Enduring Freedom Operational Concept for Strategic Bombers:	Conventional long-range attack of enemy military and infrastructure using precision munitions with secondary role of nuclear deterrence
Enduring Freedom Employment Roles of Strategic Bombers:	High-altitude bombing
	GPS-guided weapons
	Conventional bombing
	Close air support
	Show of force
Modification to Bomber Tactics and Technology	On-call close air support
	Satellite communication relay
	Targeting sensor integration
	Datalink capabilities
Current Operational Concept for Strategic Bombers:	Long-range conventional attack, close air support using precision munitions, and nuclear deterrence

Table 3: Comparison of Pre- and Post-war Operational Concepts for strategic bombers during Operation Enduring Freedom

Implications

The previous three cases studies illustrate the challenges of developing a future operational concept for strategic bombers. In each of the cases studies, the Air Force developed their concept of operations based on their perception of the enemy threat and the most appropriate way to use the strategic bomber to accomplish their objectives in the face of that threat. In all three instances, the Air Force deviated from their operational concept when attempting to employ strategic bombers during the course of a campaign. During WWII B-29 operations over Japan, air planners based their campaign on the operational concept of high-altitude, precision, daylight bombing. Bomber Command began operations against Japan using HAPDB, but could not achieve effective results in the necessary timeline and modified their employment methods to incorporate low-altitude area bombing. The Desert Storm case study revealed that the operational concept for the B-52 shifted from its Cold War role of nuclear deterrence and long-range strategic strike. The Air Force needed the conventional delivery capabilities of the B-52 to provide battlefield air interdiction and close-air support for ground troops deployed to theater.

Operation Enduring Freedom provided the final example of how the Air Force modified their strategic bomber operational concept through tactics and technology. Prior to the war, the Air Force operational concept was for bombers to provide conventional and nuclear deterrence against a major

nation state armed with former-Soviet Union weaponry. Strategic bombers destroyed all strategic targets within a few days; however, ground forces needed airpower against fielded forces to execute coalition operations. Bomber crews modified their tactics and used existing technology to provide on-call close air support for ground forces. These case studies suggest that the Air Force lacked accuracy when predicting future employment methods for strategic bombers.

The Air Force's operational concept for strategic bombing does not always match the employment methods during the course of a campaign. However, it is important to note that operational concepts will change during peacetime as well. The peacetime evolution of the roles and missions of the B-52 suggest that the Air Force changed its strategic bomber operational concept several times during the course of its life span. The post-Cold War modifications to optimize the bomber fleet for a conventional mission are even more pronounced. While modification to an operational concept is inevitable, Air Force leaders should not falsely believe that predictive accuracy in future requirements is not important. The strategic bomber experience in Enduring Freedom suggests that even with little foreknowledge of the enemy, accuracy in predicting the future employment methods leads to less turbulence during campaign execution. The closer the Air Force operational concept comes to accurately predicting the strategic bomber employment methods, the fewer modifications air planners and bomber crews will have to make to organization, technology, and tactics.

The Air Force must strive to predict future strategic bomber employment methods accurately in order to minimize turbulence and achieve the best fit for the campaign. However, the Air Force must acknowledge that it cannot perfectly predict the operational concept even when it has considerable knowledge of the enemy. The B-29 campaign illustrates how the service can have extensive foreknowledge of the enemy and still devise an operational concept that required extensive modification. The Air Force must also acknowledge that they may not be able to predict all potential enemies, conflicts, or operations in which theater commanders will require strategic bombers. Operation Enduring Freedom illustrates how, despite fundamental surprise, defense planners were able to adapt readily strategic

bomber employment to fit the operational environment. Because military leaders cannot always identify enemies or employment methods in advance, they must design strategic bombers that are competent across the spectrum of conflict.

Which leads to the question implicitly posed by the title of this monograph: How does the US Air Force design a strategic bomber? The answer is that the Air Force must design its strategic bomber based on its most accurate assessment of the future operational concept. The 2010 Quadrennial Defense Review Report suggests that the Department of Defense has begun an assessment of the capabilities that "will best support US power projection operations over the next two to three decades."[169] Certainly, this study will reveal important considerations for future aircraft design. Regardless of the characteristics recommended by the QDR study, the resultant design must remain flexible and capable of accommodating changes to the future operational concept. The ultimate design must incorporate flexibility in organization, tactics, and technique.

Organizational flexibility, as a characteristic of aircraft design, may seem counterintuitive. However, organizational flexibility is a prerequisite for developing understanding of the environment and recognizing the need to adapt. Organizational flexibility requires the capacity and capability to adapt. Capacity refers to the recognition by the organization that the environment has changed and there is a need to adapt. Peter Senge, in *The Fifth Discipline: The Art and Practice of the Learning Organization*, refers to an organization with the capacity for recognizing the need to adapt as a learning organization. He defines a learning organization as one "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together."[170]

Developing a learning organization requires cultivating an environment where leaders at all levels

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[169] Department of Defense, *Quadrennial Defense Review Report* (Washington DC: Government Printing Office, 2010), 33.

[170] Peter Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Doubleday, 2006), 3.

think and act strategically.[171] The Air Force must promote discourse between air planners and aircrew to ensure that changes in the environment are predicted when possible and recognized when not. General LeMay's Bomber Command in the Pacific theater could be characterized as a learning organization. The HAPDB campaign planned for Japan was the product of a well thought out operational concept. However, General LeMay recognized that this operational concept was ineffective in the operational environment which it was implemented. This recognition indicates that General LeMay operated in a learning organization capable of modifying its employment methods to enemy adaptations. Once organizations recognize that they must adapt, they must have the capability to do so.

The capability to adapt refers to the ability of the organization to implement the change they recognize as necessary. There are number of reasons that organizations lack the capability to adapt. One of the most frequently cited reasons is that new concepts conflict with deeply held internal images of how the world works.[172] This often affects military organizations immersed in tradition. Parochial conceptualizations of "right" artificially prejudge merit prior to accomplishing a full examination of the environment. For example, B-52's performing close-air support without being able to see the target was unthinkable to many prior to Operation Enduring Freedom. Fortunately, individuals within the organization are most often the roadblock to adaptation. The bureaucracy inherent in Air Force organizations provides opportunity for the best adaptive concepts to circumvent myopic leadership. Leaders must cultivate an environment where innovative concepts are not stifled at the individual level. Organizational flexibility is a prerequisite for adaptation, but it is insufficient to ensure effective modification of a concept of operations. Tactical flexibility is also required.

Tactical flexibility is the ability to adapt tactics, techniques, and procedures for application in novel roles. Tactical flexibility is a pervasive component of employing strategic bombers in complex combat environments. Leaders can enhance tactical flexibility by developing aircrew capabilities in two

[171] Ibid., 284.

[172] Ibid., 163.

key areas. First, leaders must develop the core competency of their aircrew in the fundamental knowledge, skills, and abilities of their craft. Bombers crews must have a solid foundation of employment tactics enabling them to perform their essential missions without difficulty. Donald Schön refers to this professional artistry as "knowing-in-action" and suggests that it is the ability to apply static rules dynamically.[173] Knowing-in-action reveals intelligent understanding of the fundamental actions required to perform a complex task, such as flying a bomber, without having to think about it.[174] Schön describes "knowing-in-practice" as knowing-in-action distributed among a community of professional practitioners, such as a squadron of bomber crews. Knowing-in-practice is the application of theories and techniques that have been refined from the professional body of collective knowledge and guide the functioning of the practice. These theories and techniques, in military parlance, are codified in doctrine as tactics, techniques, and procedures.

Second, leaders at the tactical level must foster an environment by which experimentation is encouraged through challenging crews with situations that surprise and test the proficient practitioner. Surprise leads to what Schön describes as "reflection-in-action," which questions the underlying assumptions of knowing-in-action and causes individuals to restructure their understanding.[175] This leads to a process of inquiry through which individuals explore new phenomenon and test limits of knowledge. Ultimately, practitioners will reflect on action by developing verbal descriptions and expanding the practicable knowledge of the profession. An example of this process occurred when Air Force leaders established a unit devoted to developing the necessary tactics for delivering atomic weapons. Aircrew used the fundamental knowledge of their profession (knowing-in-action) and experimented with new tactics to overcome the constraints of atomic weapons employment (reflection-in-action) to develop tactics, techniques, and procedures for the practice of delivering atomic weapons (knowing-in-practice).

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[173] Schön, 23-26.

[174] Ibid.

[175] Ibid., 26-29.

Tactical leaders must develop core competencies while challenging bomber crews to innovate and test existing knowledge structures. Lastly, the aircraft design must be technologically flexible.

Technological flexibility is the ability of the Air Force to modify existing systems and incorporate technological innovations that enhance function without compromising the integrity of the initial system. Technological flexibility is measured in gradients, not absolutes, and can vary internally within a system. All technology-based systems have some degree of flexibility, but some are inherently more flexible. For example, the Air Force may be able to upgrade an aircraft that has an external targeting pod sensor with a more advanced sensor by simply switching out the external pod. However, incorporating advances in radar design to the B-2 radar may take considerably more effort and capital to achieve. Thus, the ultimate measure of technological flexibility is the amount of labor, capital, and time that must be expended to modify an existing system in order to achieve the desired configuration.

Inherent technological flexibility is a result of the concerted effort by aircraft designers to develop incrementally upgradeable systems. Designers must identify systems that have the greatest tendency for technological advances and incorporate potential for future modification in those areas. The Air Force can identify systems where it historically has incorporated upgrades and use this as a baseline for developing technological flexibility. Aircraft systems such as radars, sensors, communications equipment, datalinks, and engines are key areas that the Air Force has historically modified to capitalize on technological advances. Aircraft designers can use these identified systems to incorporate the capability for subsequent expansion of those systems. For example, if the Air Force identifies communication datalinks as an area of technological turbulence, engineers can enhance technological flexibility by designating a location on the aircraft for mounting additional antennae, providing additional electrical capacity, and determining a location for mounting processing units. There are obvious limits to how far the Air Force can incorporate adaptability into an existing system before it becomes unfeasible. Designers may not be able to predict the form of future advances in technology. However, the Air Force must accept that future modifications to operational concepts will require technological modification and

incorporate the capability for adaptation in aircraft design.

Lastly, technological flexibility requires operational compatibility with the existing Air Force logistical system. This prevents aircraft from becoming operationally limited because of existing infrastructure. For example, the B-52's wide wingtip landing gear prevents it from using a number of airfields unable to accommodate its large footprint. Thus, the B-52 is operationally limited to specific airfields because of logistical considerations. The Air Force must examine how to design bomber aircraft to be compatible with the greatest proportion of the logistical infrastructure. Operational compatibility expands options for airpower planners to use aircraft in ways previously not considered.

The five characteristics for bomber aircraft Giulio Douhet wrote about after WWI are still present in bomber aircraft today. Range, speed, ceiling, payload, and armament are all considerations that the Air Force must weigh and balance when developing new bomber aircraft. Additionally, the Air Force must address new considerations of persistence, communications architecture, and sensor collection. The Air Force must balance these capabilities to design a strategic bomber able to perform its mission within its anticipated operational environment. The Air Force will ultimately determine the necessary balance of these capabilities, designate an operational concept, and design a future strategic bomber that meets its predicted requirements. Whatever form this takes, future airpower leaders will determine its ultimate utility by how capably the bomber can adapt to the operational environment in which it operates.

Conclusion

The Air Force did have to modify the technology and employment tactics of its strategic bomber fleet to enemy adaptations in the operational environment. The Air Force based its past operational concepts for strategic bombers on the best available theory, intelligence, and technology. Strategic bomber operational concepts have historically served as the basis for aircraft design and technological development. The Air Force deviated from their operational concept when attempting to employ strategic bombers during the course of a campaign, modifying technology and tactics to make strategic bomber operations more effective against the enemy they are fighting. Additionally, the Air Force modified their

peacetime operational concept based on enemy developments and the changing context of the environment.

The three case studies in this monograph examine B-29 operations in the Pacific, B-52 operations in Desert Storm, and strategic bomber operations in Enduring Freedom. These case studies suggest that the Air Force had to modify the tactics of strategic bombers crews and/or the technology of the strategic bomber to make it more effective against the enemy. Because Air Force planners did not have complete knowledge of the enemy or the environment, they had to modify their operational concept based on learning during the campaign. The B-29 case study suggests that the Air Force had reasonably good knowledge of the enemy, but lacked knowledge of the environment. The B-52 case study suggests that the Air Force had some knowledge of the enemy, but little knowledge of the environment. The final case study suggests that the Air Force had little knowledge of the enemy, but reasonably good knowledge of the environment. Improved knowledge of both the enemy and environment can minimize turbulence to existing operational concepts.

However, the operational concept is still a hypothesis that the Air Force must prove through combat operations. The Air Force must strive for complete knowledge of the enemy and environment, but assume that they will never achieve full understanding. Therefore, the Air Force must design flexibility into the organizations, tactics, and technology they use to implement their operational concept. Organizational flexibility requires the capacity and capability to adapt. Tactical flexibility requires core competency in fundamental employment tactics while continuing to question and test existing techniques. Lastly, technological flexibility requires aircraft designed for operational compatibility with existing logistical structures while remaining incrementally upgradeable in areas of historic technological turbulence.

This monograph suggests three areas for future research. First, researchers should identify retired bomber aircraft and examine why the Air Force chose not to, or was unable to, modify those aircraft. Perhaps research in this area will reveal lack of technological flexibility or inability to adapt to the

changing operational concept for strategic bombers. Second, researchers should examine systems that the Air Force has historically modified and identify emergent trends. This may assist aircraft designers in focusing potential areas for incorporation of emergent technological advances. Finally, researchers should examine aircraft remaining in the Air Force inventory for extraordinary lengths of time and identify the characteristics that have contributed to their longevity. The B-52, KC-135, C-130, and U-2 continue to serve the needs of Air Force leaders and planners despite remaining in service for over fifty years. Perhaps an examination of these aircraft will reveal common characteristics that enhance the Air Force's capability and capacity to adapt them to the current operational concept.

America's military has balanced increased operational tempo against a constrained budget over the past decade. Aircraft development programs will encounter increasingly strict scrutiny from congressional approval processes. The aircraft that emerge from this process will remain in the inventory for extended periods despite potential flaws. The Air Force must consider how to enhance the flexibility of this fleet in order to adapt to future operational concepts.

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